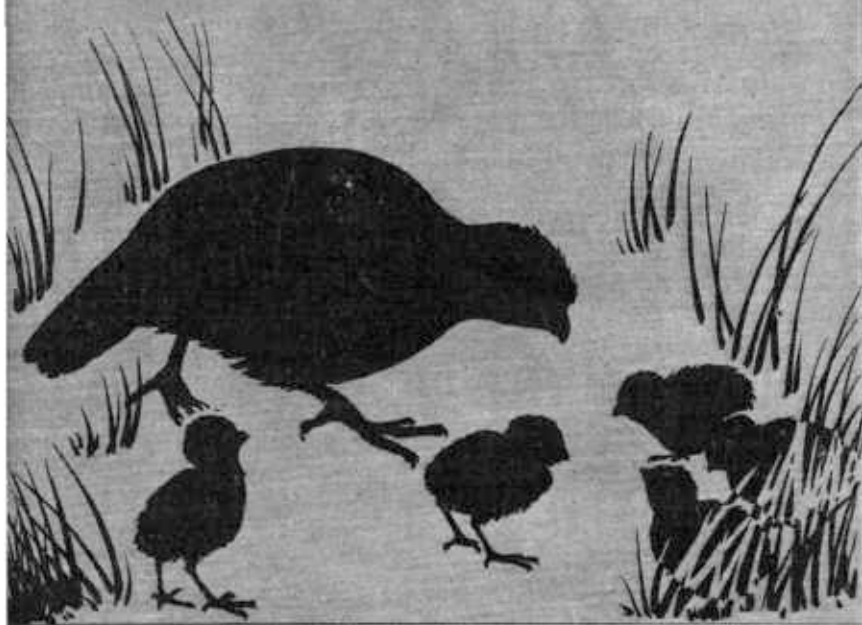


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Diseases of Upland Game Birds



FARMERS' BULLETIN No. 1781

UNTIL RECENTLY the diseases of upland game birds received comparatively little specific study, except in a few outbreaks in which serious losses were observed. Though highly destructive, many of these outbreaks were of such short duration that the investigations undertaken were chiefly to learn the cause of death and usually were discontinued when losses were no longer noticeable. It has become increasingly evident, however, that every year great numbers of game birds die of disease, the decreases in their numbers frequently occurring in sections closed to hunting, even though food, cover, and other environmental conditions appear ideal. The disease problems are multiplied on game farms when wild species are subjected to unnatural conditions on enclosed ranges. Although the sanitary equipment there provided tends to reduce the likelihood of disease outbreaks, the fact that large numbers of the birds are held in close contact in a restricted range has frequently militated against their health. During the past few years, therefore, for game-management purposes, the Bureau of Biological Survey has attempted to gather more complete information on disease control, through its own research and through collaboration with other institutions. The results are here set forth to assist organizations and individuals concerned with the management of upland game birds.

DISEASES OF UPLAND GAME BIRDS

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DISEASE PREVENTION AND CONTROL

THE EFFECTS on upland game birds of external and internal parasites, pathogenic micro-organisms, defective nutrition, digestive disturbances, and inherited abnormalities are all considered disease conditions. The tissue changes and the resulting impairment of body functions are so numerous that in a bulletin of this kind it is practicable to discuss only the more common and important ailments of game birds now known to cause losses on game farms and in the wild. While some of these can be recognized even on casual observation, others are so obscure as to escape detection except by a trained pathologist.

LOSSES AMONG WILD GAME BIRDS

Wild game birds are subject to all the diseases common to birds propagated on game farms, but it is not yet known to what extent diseases account for losses in the wild. For many years phenomena

¹ The authors gratefully acknowledge many helpful suggestions made in the preparation of this bulletin by specialists of the Bureau of Animal Industry and the Bureau of Entomology and Plant Quarantine.

have been noted that are spoken of as a cyclic or periodic disappearance of certain species. Thus far investigations have not covered completely one of these cycles from scarcity to abundance and again to scarcity with observations sufficiently close to detect the cause. Certain conditions of the cycles, however, with several years of scarcity merging into a gradual increase to abundance, followed by a precipitate decline almost to complete disappearance, point strongly to disease as an important factor.

The devastating effects of virulent diseases upon dense populations of susceptible subjects of any class is well known. Since records show disastrous decimations in the presence of ample food, cover, and satisfactory environment, the cause of the losses must be looked for elsewhere. The ease of transmission of pathogenic organisms in dense populations, the tendency of many organisms to increase in virulence when passed rapidly from one subject to another, and the ample means for disease transmission, including biting insects, all tend to give support to the hypothesis that disease is responsible for the sharp declines in game populations in the wild following periods of maximum abundance.

It is difficult, however, to find sick and dead game birds in their natural habitat. Sick birds are not inclined to come into the open, and the colors of their plumage often make it hard to see them. Moreover, various carrion-eating animals may destroy carcasses quickly and leave no trace of them. Thus the severe decimation that often takes place in the wild may not be apparent until the birds are sought by sportsmen.

Because of their comparatively greater isolation, except in cases of overabundance and in other rare instances, wild birds are not subjected to the ravages of epizootics so frequently or to such a disastrous extent as birds concentrated on game farms sometimes are. A clear understanding of the disease situation among wild game birds can be gained only by close study of the various species over long periods by specially trained investigators.

Preliminary studies, however, have revealed some facts with regard to the diseases of game in the wild. Frequent infections of quail and wild turkeys with blackhead have been noted, and wild grouse and quail have been taken that showed definite lesions of ulcerative enteritis. All game species are known to be parasitized by a large variety of worms and protozoa, many of which are not found in pen-raised game.

Probably it will never be possible for game managers to apply disease-control measures so effectively in the wild as on game farms, and as yet no well-defined practices can be recommended for the suppression of disease in natural environment. It is suspected, however, that during periods of deep snow or in prolonged, severe winters, parasitic and other diseases may be spread through close contact of game birds unless their feeding stations are shifted occasionally to new ground. Such measures can be recommended as will prevent overpopulation or undue concentrations of game and reduce the number of factors that tend to spread disease.

The fact that losses in wild game birds are most pronounced during periods of greatest abundance points to unhygienic factors associated with crowding as being responsible. Where bird popula-

tions are dense, disease-producing organisms, including internal and external parasites, have the greatest opportunity for becoming numerous. Likewise the droppings from large flocks facilitate the spread of disease by increasing the pollution of ranges and roosting sites. To reduce such possibilities to the minimum, game managers should prevent overpopulation by judicious shooting in season when necessary. The abundance of insect carriers of disease may also be reduced by carefully controlled burning of game ranges early in the spring.

In connection with conservation and restoration efforts, due consideration should be given to causes of loss of game birds in the wild. Fuller knowledge of the distribution of game-bird diseases should aid in the application of measures for reducing waste of a valuable natural resource.

SAFEGUARDING GAME FARMS

Controlled breeding, feeding, and housing in quail or pheasant farming have now been so perfected as to make reasonable reproduction more or less definitely sure. Outbreaks of disease, however, may cut down the increase and thus reduce the prospective farm profit to a sudden loss. The hazard from disease can be greatly reduced by carefully following certain established principles.

PROPER FEEDING

Correct nutrition is one of the most important requisites in maintaining good health among birds on the game farm. Poorly nourished birds succumb more readily to debilitating diseases than those adequately fed. Nutritional irregularities themselves, when sufficiently great, will cause disease. Improvements are constantly being made in feeds and in methods of feeding, and the systems now in vogue are comparatively simple and well-standardized.

SANITATION AND SANITARY CONSTRUCTION

The establishment of an environment favorable to health in the broad sense is essential to the avoidance of disease. Most of the destructive diseases of game birds are due to some form of infection, the causative organisms of which can be eliminated to a large extent by doing away with the conditions under which they thrive. Accumulations of droppings, of uneaten food, and of decaying litter are favorable to the growth of many disease organisms. Such accumulations should frequently be removed. Hot water should be freely used, with vigorous scrubbing, to keep utensils and soiled parts of buildings sanitary. Digging up earthen runs so as to aerate and dry the topsoil aids in destroying infective organisms, as does also the practice of allowing pens, coops, and brooders to remain idle for extended periods.

Much can be done to prevent and eliminate disease by selecting the proper sites and designs for game-farm buildings and pens. Where there is a light, gravelly soil with good drainage, the water will be absorbed rapidly after a rainfall and will not remain long in depressions. Brooders and coops with solid floors should be so arranged that they can be easily cleaned. There should be no

crevices or uneven places that tend to hold filth. In pen construction it is well to use hardware cloth for the floors, so as to allow droppings and waste to fall through and be disposed of. When hardware cloth is so used, care should be taken to eliminate ledges and flat framework supports, as these also collect wastes.

Every practicable means for eliminating flies and other potential carriers of disease from the premises should be employed. The pens should be situated far from stables and from piles of manure and other debris that serve as breeding places for these insects, and all feed that may attract them should be kept covered. When pens are of such small size as not to make the cost prohibitive, they should be screened against troublesome insects.

CHEMICAL DISINFECTION

Many game farmers depend too much upon the action of disinfectants, to the neglect of proper sanitation. Chemical disinfection is effective only when gross accumulations of waste have been taken away, since the disinfectants ordinarily used lose much of their germicidal power when in contact with large quantities of organic matter. Before any form of disinfection is attempted, therefore, all manure and litter should be removed.

The floors and walls of pens and coops that have been occupied by diseased stock should be scrubbed with a stiff brush. The addition of 1 pound of commercial lye to 5 gallons of warm water for scrubbing the equipment aids not only in removing dirt but in destroying disease germs. Care should be taken to prevent the lye solution from coming in contact with the skin as it has a corrosive action. The use of rubber gloves or a long-handled brush is advised. In lieu of this procedure the scrubbing may be done with a solution of washing soda and after allowing time for drying some reliable coal-tar disinfectant may be applied. Spraying a 5-percent carbolic acid solution or a 3-percent compound solution of cresol is recommended for driving the liquid into all the crevices.

Various oils are effective in ridding premises of certain insects. Kerosene, either alone or mixed with a heavier oil, aids materially in destroying many micro-organisms, especially protozoa and the larvae of worm parasites. Bichloride of mercury is not satisfactory for this purpose.

Heat applied by the use of steam, boiling water, or direct flame is valuable in destroying infectious organisms, including bacteria, protozoa, and the eggs and larvae of parasitic worms. Generally, however, the inconvenience and expense of doing thorough work with heat precludes its use.

Birds should not be placed in coops or brooders that have been washed or treated with a liquid disinfectant until the structures are entirely dry. Injury may result to young birds placed in creosoted coops or brooders that have not been well aired out. When coops and brooders are not in actual use, their interiors should be exposed to the sun.

QUARANTINE

Before new stocks of game birds or bantam chickens for foster mothers are introduced onto a game farm, they should be kept in quarantine for at least 2 weeks. During this period of isolation the

attendant will have opportunity to make frequent observations for detecting evidences of parasitism or other forms of disease. Serious losses may be prevented by effective quarantine. Infectious diseases do not develop spontaneously but usually result from the introduction of causative organisms from outside.

Quarantining is not so practicable when ranges are stocked with pen-raised birds. While it is important to have healthy birds for liberation, usually no enclosures in which they can be held under observation are available other than the shipping crates. Because of their small size, these crates actually encourage the development of disease and its spread from bird to bird by close contact and by droppings contamination; stock should not be kept in them any longer than necessary.

BACTERIAL AND FILTRABLE-VIRUS DISEASES

The diseases caused by bacteria and filtrable viruses here discussed are those ordinarily called infectious.

ULCERATIVE ENTERITIS (QUAIL DISEASE)

Ulcerative enteritis, the most formidable epizootic disease of quail and grouse in captivity, affects the common bobwhite, the California valley, Gambel's, and mountain quails, and the sharp-tailed and ruffed grouse. The fact that ruffed grouse are susceptible indicates that ulcerative enteritis may possibly be a factor in the periodic decimation of that bird in this country. A similar epizootic has long been a pestilence of red grouse in Scotland, where such features of the disease as seasonal occurrence, mode of attack, and general character of lesions strongly suggest that the infection is closely related to ulcerative enteritis if not actually identical with it. Similar epizootics, with the presence of characteristic ulcerations, have been observed in wild and domestic turkeys. Domestic chickens have rarely been found to be affected with the disease, though they may serve to spread the infection.

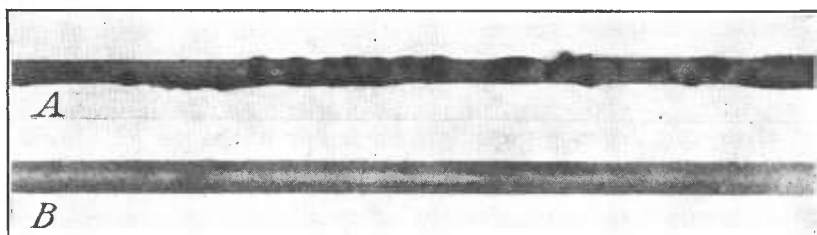
Cause.—Although the cause of the disease has been in dispute for some time, investigators are agreed that it is of bacterial origin. A micro-organism (*Corynebacterium perdicum*) has been recently reported as the cause of ulcerative enteritis. It can readily be transmitted experimentally by feeding test birds on the droppings, intestinal contents, or ground intestinal tissues of affected birds. Failure to transmit the disease by means of the blood or body tissues indicates that it is essentially an intestinal infection.

Spread.—Contaminated food and water are the factors commonly responsible for the spread of ulcerative enteritis. The disease may also be carried from pen to pen on the shoes of attendants or by insects or birds. Outbreaks are common when there is much rainy weather, as late in the fall or early in the spring. Overcrowding and the excessive accumulation of droppings in ground pens favor the disease and encourage its spread, particularly when the birds ingest the excrement of diseased individuals.

Symptoms.—Birds chronically affected with ulcerative enteritis appear dull and listless, with feathers ruffled. Extreme emaciation is noted, the birds sometimes losing from a third to a half of their

weight. A diarrhea develops, characterized by white deposits on the floor of the pen. Individuals that are affected with a chronic form of the disease may live 2 or 3 weeks, though in the acute stage some may die before symptoms appear or the characteristic lesions develop. The period of incubation varies, but the average is about 4 days.

Post-mortem appearance.—On post-mortem examination of acute cases, lesions may be lacking, except for minute hemorrhages in the intestine. The less acute cases that live 3 or 4 days or longer usually show gross pathologic changes confined principally to the intestines, lungs, and liver. The intestines usually are found to be studded with small lentil-shaped ulcers that can be seen through the intestinal wall (fig. 1). These ulcers frequently perforate the intestinal wall, and in such cases, if death is delayed, the visceral organs may be bound together by adhesions. The duodenum is sometimes greatly enlarged and is reddish purple in color. The lungs are regularly congested and occasionally exhibit areas of consolidation. The liver is usually congested and may have extensive areas of superficial grayish-brown necroses.



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FIGURE 1.—Part of diseased intestine of bobwhite, showing (A) characteristic lesions of ulcerative enteritis and (B) corresponding normal intestine.

Prevention and control.—No medicinal treatment is known to be of value in the prevention or cure of ulcerative enteritis. Rigid sanitation must be practiced, for the disease is regularly spread under game-farm conditions by means of the droppings. Keeping birds in small groups in pens with wire-mesh floors is the best preventive measure. The daily shifting of movable pens to ground not previously used will retard the spread of the malady. Dust boxes and other objects on which droppings may collect should be removed, and feed and water containers should remain in the pens only for the short time necessary for actual use. Rigid sanitation may be advantageously supplemented by chemical disinfection of pens and containers.

PULLORUM DISEASE (BACILLARY WHITE DIARRHEA)

Pheasants appear to be the game birds most susceptible to pullorum disease. Though an acute and highly fatal infection of young chicks, fortunately it is not a serious problem on game farms in this country. Pheasant breeders in Great Britain, however, report heavy yearly losses from it. The bobwhite quail can be artificially infected, and

recovered birds will show a positive reaction for a short period by the agglutination test. However, the disease has not been encountered on the quail farms on which extensive tests have been conducted.

Cause.—Pullorum disease is caused by the organism *Salmonella pullorum*, which produces a toxin that may cause death in a very short time. It is commonly transmitted from the hen to the young birds through the egg. The entire hatch in an incubator may become diseased by contact with a few individuals hatched from infected eggs.

Spread.—The disease may remain dormant in the reproductive organs of mature birds and its presence be unsuspected until in some cases it becomes active and an occasional bird is lost. The infective organisms are passed in enormous numbers in the droppings, and one individual placed in a brooder house may spread the infection to all the healthy birds. The disease may also be carried mechanically on feed and water utensils and on the feet of attendants.

Symptoms.—The symptoms of pullorum disease in young birds are the same as those of other infectious diseases, so that its presence can be determined only by special laboratory methods. The incubation period is short, and young birds may die suddenly after hatching without showing marked symptoms. Affected birds have a drowsy and dejected appearance. The name "bacillary white diarrhea" has been used to describe the disease, since diarrhea is a common symptom. The droppings, which are usually white and foamy, may cling to the down in the region of the vent, eventually sealing it. This condition, which is commonly referred to as "pasting up behind", gives the bird a bloated appearance and hastens death. A similar condition may follow digestive disturbances and other diseases and should not be considered characteristic of pullorum disease only.

Port-mortem appearance.—No distinctive lesions of this disease are found on post-mortem examination. Absence of visible changes in the liver or other organs, however, does not necessarily indicate absence of infection. The lungs are usually congested. The heart, lungs, and intestines may contain whitish areas of necrosis. Failure of the yolk to be completely absorbed may sometimes occur, but this is frequently observed also in young birds that have died from other causes, such as a weak constitution or faulty incubation and brooding.

Prevention and control.—The first requirement for prevention of pullorum disease on game farms is that carriers must be eradicated from the breeding stock. The agglutination test, which is highly efficient and is adapted either to the laboratory or the field, can be used to identify them. All chickens kept on a game farm should be tested regularly for the detection of carriers. The causative organism is easily destroyed by direct sunlight, heat, and the use of disinfectants, but under favorable conditions it may remain virulent in the soil for a long period. No medicinal treatment is of any value, and even if such treatments were possible they might be undesirable, since birds apparently recovered are frequently carriers. Sick birds should be killed and burned, and practical methods of sanitation and disinfection should be employed.

TUBERCULOSIS

Most domesticated and wild birds are susceptible to avian tuberculosis. This disease has been observed in the ring-necked, golden, Impeyan, and Reeves's pheasants, the ruffed grouse, the chukar and Hungarian partridges, the wild turkey, and the California valley and bobwhite quails, as well as in various small birds and most species of waterfowl. It is in pheasants and wild turkeys, however, that the disease appears to be most common, probably because these birds are frequently incubated and brooded under infected domestic chickens. It may become a serious problem on game farms where game and domesticated birds are closely associated.

Cause.—The form of tuberculosis commonly found in birds is caused by the typical avian strain of the tubercle bacillus *Mycobacterium avium*. This organism has characteristics that differentiate it from the bovine and human varieties, and its transmission to mammals is of such rare occurrence as to be negligible.

Spread.—The disease is usually introduced on game farms by new stock, by affected domestic chickens used for incubating and brooding, or by small birds that have associated with infected poultry. It has, however, been found in pheasants that apparently had not been raised on game farms. The liver and the intestines are commonly affected, and as a consequence the causative organisms are abundant in the intestinal content. The chief portal of entry of the infection is the mouth, and the spread of the disease is accomplished principally by birds eating feed contaminated by infected droppings.

Symptoms.—The progress of the disease is slow, and symptoms are usually not apparent until a gradual loss of weight is noticeable. The birds become weak and may be extremely emaciated before death. Tuberculous birds may move about very little, either because of general weakness or involvement of the joints, and are frequently observed to be lame. Affected individuals are listless and sit with ruffled feathers, but their appetites usually remain markedly good, even in advanced cases.

Post-mortem appearance.—Avian tuberculosis affects principally the visceral organs; the lungs are rarely involved. Visible lesions are ordinarily found as grayish white or yellowish nodules of varying size in the liver and spleen and along the intestines, or as larger, more-advanced tubercles, containing a yellowish cheese material. The presence of tubercles results in secondary degenerative changes in the liver, which becomes enlarged, pale, and friable (fig. 2). In advanced cases the spleen is involved and becomes enlarged. Emaciation may be of such an extent that only traces of the breast muscles remain. Definite diagnosis by examination in the field is not possible but is readily made by laboratory methods. A heavy infestation of parasites or infection with blackhead or other debilitating diseases will also cause a marked loss of weight, thus simulating tubercular effects, and the lesions of blackhead or of tumors may be confused with tuberculosis.

Prevention and control.—Game birds should be kept far removed from poultry flocks. To avoid spreading the infection from diseased hens to healthy young game birds, mechanical incubators and brooders should be used. Unthrifty birds should be disposed of, but

the most practicable method of eradicating an extensive outbreak of the disease is to dispose of all birds. To prevent the introduction of the disease in healthy birds used for restocking, pens and utensils should be disinfected and infected soils temporarily abandoned. The flame of a torch, a 5-percent solution of carbolic acid, a 3-percent solution of compound cresol, or a 10-percent solution of formalin, applied by spraying, may be used. The intradermal tuberculin test, used in poultry flocks for the detection of birds affected with tuberculosis, is satisfactory as a guide in removing affected foster mothers, but thus far this test has not been applied to game birds.

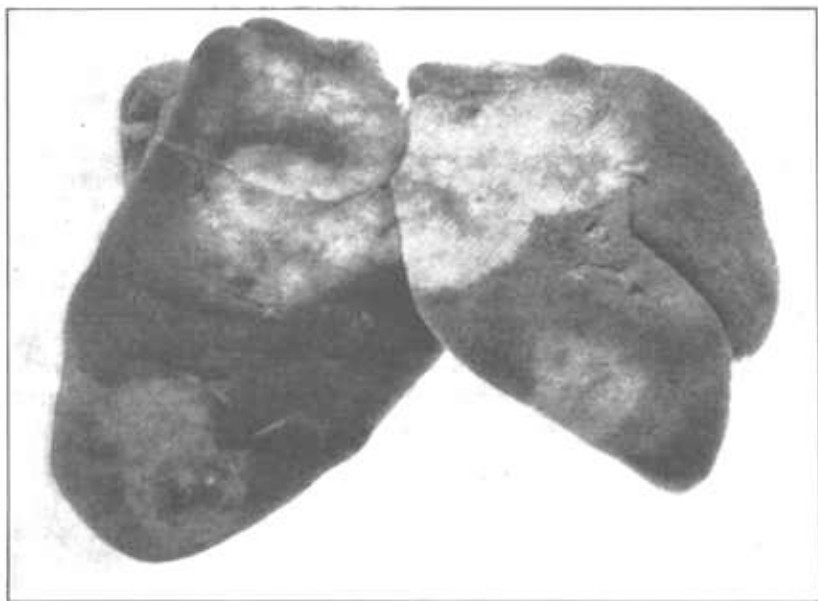


FIGURE 2.—Liver of pheasant with characteristic lesions of tuberculosis. The areas that are lighter in color show marked degenerative changes.

TULAREMIA

Tularemia is frequently considered essentially a disease of rabbits, and for this reason the term "rabbit fever" has commonly been applied to it. During recent years, however, research has shown that it may occur in other mammals and in a great variety of birds. Among the important wild game birds in which the disease has been found are bobwhite quail, ruffed and sharp-tailed grouse, and sage hens. Pheasants, however, are found to be highly resistant. It is encouraging to note that no case of this disease has been observed in birds raised under controlled conditions on game farms. The birds raised there are equally susceptible, but the manner in which they are kept usually does not expose them to the infection.

Cause and spread.—The causative organism, the highly infectious bacterium *Pasteurella tularensis*, is found in one or more forms in practically all parts of this country, and it has also been reported from various localities in Canada, Europe, and Asia. It is capable

of infecting through the unbroken skin, and many laboratory workers fall victim to it despite systematic precautions. Under field conditions, regular agents of dissemination are certain insects, especially deer flies, and also ticks. Tularemia may assume epizootic form in some animals, but as yet it has not been found to be the cause of widespread losses among game birds.

Symptoms.—Affected birds show no characteristic behavior other than that accompanying any infectious disease causing fever. The birds are not disposed to move about and feed and are inclined to sit quietly, with their feathers ruffled. There is a gradual weakening following the first symptoms, until death occurs. The different types of the disease vary in virulence from a form that is rapidly fatal to forms that cause little or no noticeable discomfort. In a number of cases the disease organism has been isolated by injecting into test animals tissues from affected birds shot on the wing, and therefore still quite vigorous.

Post-mortem appearance.—On autopsy it is not always possible to find lesions indicating infection with tularemia. The causative organism frequently has been isolated from the carcasses of birds showing no visible symptoms of it. Sometimes the only noticeable change is a deep-red color of the lungs. Often the liver and spleen also are a somewhat deeper red than normal and the latter may be slightly enlarged. What may be considered as characteristic lesions, however, are white or yellowish white spots on the liver and spleen. While there may be only a few of these, they generally become so numerous as to give the organs a grayish appearance. These spots are necrotic areas and are found in the interior of the organs as well as on the surface.

Prevention and control.—Available information on tularemia among wild game birds is as yet too meager to establish specific principles of prevention and control. In nature the disease is spread largely by ticks, and hence measures that reduce these parasites, such as carefully regulated burning, may lessen its extent. The dissemination in the wild of very mild strains of the causative organism that may immunize but not kill has been proposed. Since diseases spread more rapidly where the birds are numerous on restricted areas, however, it appears that the most effective control for possible widespread losses will continue to lie in the prevention of overdense populations.

Because tularemia is a disease that not only affects wildlife but may also be a serious and sometimes fatal infection of human beings, hunters of upland game should be on the lookout for it. Sick birds or those exhibiting any symptoms of the disease should not be handled without rubber gloves. Whenever specimens are suspected of being affected, an effort should be made to have a diagnosis made by a competent investigator. If persons who have handled suspected birds or other wild animals later experience such symptoms as enlargement of lymph glands, ulceration at the site of infection, chills, weakness, or fever, they should immediately report to a physician. It is possible to become seriously ill with tularemia even though there may be no external lesions. Vaccine for the prevention of tularemia in human beings has been developed but as yet is not in wide use.

INFECTIOUS RHINITIS OF PHEASANTS

Cause and spread.—Rhinitis is an infectious respiratory disease of pheasants and barnyard fowls and may spread rapidly under game-farm conditions. Recent investigations indicate that it is caused by the bacterium *Hemophilus gallinarum*.

Symptoms.—The disease affects principally the nasal passages and sinuses and is characterized by a bloody or mucoid nasal discharge. The membranes of the eyes may be inflamed, and the resulting discharge tends to seal the eyelids together. General symptoms, such as loss of appetite and emaciation, are frequently in evidence. Some toxic agent associated with the infection rather than the respiratory involvement alone is believed to be responsible for the high mortality sometimes observed, especially in young birds.

Prevention and control.—General sanitary measures should be observed, and the pheasants should be separated from domestic chickens. Irrigation of the nasal passages may be beneficial, but individual treatment is often impracticable.

QUAIL RHINITIS (CATARRH)

Quail rhinitis, or catarrh, commonly referred to also as “snuffles”, is an acute, highly fatal respiratory disease of young bobwhites. The heaviest losses are encountered in birds between 2 and 3 weeks of age, but under extraordinary conditions birds 5 and 6 weeks old are affected.

Cause and spread.—The cause of the disease is unknown. Transmission experiments with the nasal discharge and droppings of affected birds indicate these to be noninfective for healthy individuals. Attempts to transmit the disease by direct contact and by the inoculation of body tissues have thus far failed. The disease may be a nonspecific infection in birds with a lowered vitality, following radical changes in weather conditions or inconstant brooder temperatures. Outbreaks commonly follow unusually cool, rainy weather or a series of extremely hot days with cool nights. The disease is most frequently observed on game farms where artificial brooding methods are used. It is rarely encountered in older chicks or among those brooded by an adult bird.

Symptoms.—The symptoms displayed are characteristic of a respiratory infection and in many ways resemble those of roup in chickens. Affected birds are slow and droopy and lose appetite. The outstanding symptom is a frequent sneezing and gasping for breath. There is an excessive secretion by the membranes of the respiratory passages, and the birds make an audible sneezing sound while shaking the head in efforts to clear an obstruction from the air passages. The disease usually makes its appearance simultaneously in all the brooder houses or coops in which birds of the same hatch are confined. Heavy losses may be sustained before noticeable symptoms are manifested, as death occurs shortly after the first symptoms appear. Affected birds seldom recover.

Post-mortem appearance.—Tissue changes are slight, and no characteristic lesions are observed on post-mortem examination. Inflammation of the respiratory passage and an excessive secretion may be seen, but in very young birds these lesions may pass unnoticed.

Treatment.—No known medicinal treatment is of any avail. When the disease makes its appearance it is advisable to check up promptly the temperature of the brooders over a period of at least 24 hours. A high temperature probably is to be preferred, for with sufficient space and ventilation the birds can properly adjust themselves to the conditions by moving away from the heating unit. Affected birds frequently recover when temperature irregularities are corrected. Very little is yet known concerning the humidity requirement of young quail under artificial brooding conditions.

FOWL TYPHOID

Fowl typhoid is a specific infectious disease of domestic chickens, but little is known of its occurrence among propagated game birds. The infection has been observed in birds in zoological gardens. Bobwhite quail as well as other game birds have been found susceptible, but there are no authentic reports of the disease as a spontaneous infection on game farms.

FOWL CHOLERA

Fowl cholera is an acute, highly infectious, and rapidly fatal disease of domestic chickens and may cause heavy mortality before effective control measures can be instituted. It has been encountered in wild ruffed grouse; and geese, ducks, turkeys, pheasants, pigeons, quail, and a large number of other wild birds are susceptible. Existing information, however, indicates that in this country the disease is of rare occurrence either on upland game farms or among wild birds.

FOWL POX (AVIAN DIPHTHERIA)

Fowl pox is an infectious disease of common occurrence in domesticated birds and in pheasants, turkeys, quail, and other wild birds. Outbreaks cause heavy losses in young birds on game farms in the Southern States. The disease is characterized by the presence of eruptions on the mucous membrane of the mouth and throat and is frequently called "avian diphtheria."

Cause and spread.—The disease is caused by a virus that passes through bacterial filters. It is introduced on game farms in the same manner as are other infectious diseases and may be spread by mites and biting insects. Fleas have been shown to act as mechanical carriers of the virus and thus to transmit the infection from affected to healthy birds.

Symptoms.—The incubation period and duration of symptoms may vary from several days to several weeks. The severity of the disease is dependent upon the extent of mucous-membrane involvement and the resulting toxemia. Young birds usually show an acute form of the infection and die before external symptoms are noticeable. In older birds the disease more regularly assumes a chronic course. There are no characteristic symptoms other than extreme dullness and loss of vitality.

The disease is usually manifested by a nasal discharge, which becomes viscid and obstructs the air passages, compelling the bird to breath through the mouth. A watery discharge gums the eyelids

and obstructs vision, and the conjunctival sacs fill with a cheesy exudate that gives the eye a swollen appearance. The mucous membranes of the mouth and throat contain diphtheritic deposits. The ulcerations are covered by a false membrane of thick, yellow, cheesy exudate that may cause death from suffocation by obstructing the air passages.

Prevention and control.—The best safeguard against fowl pox is to keep game birds as far removed from poultry flocks as possible, as the infection may be contracted from chickens. In the South, fleas are an important factor in the transmission, and consequently affected birds must be isolated or destroyed to prevent the spread of infection. Vaccination for this disease in domestic chickens has proved effective but thus far has not been found practicable on game farms. Where domestic chickens are used for incubating and brooding game birds, it is recommended that they be examined thoroughly for lesions of pox or diphtheria before they are given a clutch of eggs for hatching or young birds for hovering. Recovery from fowl pox can be aided by removing accumulations from ulcerations in the mouth and applying a mild antiseptic.

PNEUMONIA

The term pneumonia is here used to designate any inflammation of the lungs. In game birds it may arise from a number of causes and is frequently associated with many of the infectious diseases. An uncomplicated pneumonia due to specific pneumonic organisms alone is of rare occurrence in birds. Inflammation of the lungs may follow an irritation caused by noxious gases or dust, or it may be induced by the extension of inflammation of the mucous membranes of the upper air passages. It is more often attributable to exposure, cold drafts, and dampness. Propagated game birds that are handled during cool, rainy weather may be affected if they become wet and chilled.

Symptoms.—The characteristic symptoms of pneumonia are rapid breathing and physical signs of distress, and they may be accompanied by a watery discharge from the eyes and nostrils.

Treatment.—The treatment depends largely upon the cause. If the disease appears to be of infectious origin, an attempt should be made to control its spread by destroying the sick birds. Birds affected as a result of exposure to cold drafts or dampness should be placed in warm quarters and given an increased ration of green feed.

FUNGOUS DISEASES

ASPERGILLOSIS

The most common of the fungous infections that attack game birds is aspergillosis. This disease occurs frequently in baby chicks in poultry plants and is there referred to as "brooder pneumonia." It may affect any of the propagated birds and frequently is prevalent on game farms, in zoological parks, and in aviaries. The wild birds most commonly affected are the various species of waterfowl, especially swans and geese.

Cause.—Aspergillosis is caused by a fungus of the genus *Aspergillus*. The species *A. fumigatus* appears to be the most pathogenic of the group, and it is most commonly associated with the infection. Birds that feed on moldy litter may become infected, as the disease is usually contracted from decaying vegetable matter. Pine needles, which are used extensively on southern game farms to cover runs and brooder floors, have been known to introduce the infection. The disease is contracted by inhalation of the spores during the course of feeding on moldy grain or scratching in moldy litter. The lungs and air sacs afford favorable conditions for the development of the spores.

Symptoms.—Symptoms of aspergillosis in birds may pass unnoticed by the casual observer. Usually the first symptom seen is difficulty in breathing, which progresses rapidly until suffocation causes death. Affected birds usually mope and sit with ruffled feathers. Increasing weakness and emaciation may be the only symptoms shown when the infection is confined to the large air sacs. Young birds may die within the course of a few days, but mature birds may live a month or more after the symptoms are manifested.

Post-mortem appearance.—Aspergillosis can usually be recognized on autopsy by the presence of cheesy deposits in the trachea and firm white circumscribed nodules in the lungs and air sacs and around the heart. Lesions also may be found in other body tissues. In advanced stages of the disease the tissues may be covered by elevated yellowish or greenish growths of the organism, which somewhat resemble common bread mold.

Prevention and control.—Infection may be prevented by the use of litter free from mold. If litter is essential, only that which appears bright, clean, and free from moldy or musty odors should be used. There is no treatment for the affected individual; aspergillosis is always fatal. Sick birds should be removed, and the bodies of dead birds should be burned.

THRUSH

Thrush is an infection of birds caused by a fungus (*Oidium albicans*). Turkeys, quail, and other game birds are susceptible to the disease, and on quail farms it may sometimes cause a high mortality among young birds. It is frequently characterized by whitish ulcers or pseudomembranes in the mouth and crop, mucoid deposits in the proventriculus, and ulcers in the gizzard. The infection may be of such extreme virulence, however, as to kill before any but slight pathological changes are produced. Loss of appetite, weakness, and emaciation are the usual symptoms.

Sick birds should be isolated to prevent the spread of the infection. Visible deposits in the mouth and throat may be mechanically removed and the affected parts treated with a mild antiseptic solution.

DISEASES CAUSED BY INTERNAL PARASITES

An organism that lives on or within and at the expense of another is known as a parasite. Since the presence of all parasites is more or less detrimental to the host on which they live, the harmful results of their action must be regarded as a disease. Most external and

internal parasites are of a size readily visible to the experienced observer, though some of the smaller forms are likely to be overlooked unless diligently sought.

Many worms are known to parasitize game birds, both under controlled conditions and in the wild. In some instances, wild birds exhibit massive infestations of one or several species, but modern understanding of sanitation and of the means by which internal parasites may be spread can reduce their prevalence to a point where they need no longer be a serious menace on game farms.

The harm done by parasites varies with the type. In many instances the greatest injury is to the immediate tissues attacked, in which case wounds are made by the biting organism or by the parasite's burrowing into internal tissues. In some instances the harm may be largely in the nature of interference with the digestive process, while in others, toxic substances may be set free in the host.

PROTOZOAN DISEASES

COCCIDIOSIS

Coccidiosis is a disease of the intestinal tract caused by a protozoan parasite. It is not generally prevalent on well-regulated game farms, but where sanitation is lacking or when birds are overcrowded severe losses may occur.

A number of different species of coccidia have been found in the ruffed grouse, ptarmigan, quail, and other game birds. Although coccidiosis is thought to be partly responsible for the decrease of red grouse in the British Isles and the willow grouse in Norway, the importance and prevalence of the disease in wild birds are yet to be determined.

Cause and spread.—Coccidia multiply in great numbers in the lining of the intestinal tract, causing the death of cells and marked inflammation of the intestine. A bird cannot long withstand this extensive destruction of tissue combined with the loss of blood, and death soon results. The disease is spread by a resistant form of the organism known as the oocyst. Large numbers of the oocysts are passed in the droppings of infected birds, contaminating the feed and the soil of the pen. The organism may be mechanically carried and spread on the shoes of attendants or by birds and insects.

Coccidia are generally host-specific; that is, those that are commonly found in birds of one species are not likely to infect other birds. No interchange of infection between birds and mammals has been reported. Early workers considered all coccidia found in birds to be of one species, but later investigations have shown that game birds are parasitized by a number of different species. The domestic chicken is known to be affected by at least six.

The two species of coccidia found in turkeys are common to both the domestic and wild varieties. The species usually found in the ring-necked pheasant are *Eimeria phasiani* and *E. dispersa*. Although coccidia resembling *E. tenella*, *E. acervulina*, and *E. mitis* of the domestic chicken have been found in the quail of Ohio and California, the species frequently found in the bobwhite (*E. dispersa*) is not transmissible to poultry.

Symptoms.—Dullness is the principal symptom, but in some cases a diarrhea with considerable blood in the droppings may be observed. Young game birds are usually the most severely affected, and death may result before the nature of the disease is realized. A diagnosis of coccidiosis can be made only by the microscopic finding of a large number of the oocysts in the intestinal discharges. The widespread occurrence of light infections of coccidia in birds tends to lessen the significance of the finding of a few oocysts in the droppings, since apparently normal wild mammals and birds may harbor a limited number of the organisms without exhibiting symptoms of the disease.

Post-mortem appearance.—The lesions resulting from a coccidial infection vary considerably, depending on the host and the species of the organism involved. Examination of a bird that has died of the disease may show an intense, bloody inflammation of the intestinal wall; or the intestinal pouches or caeca, which are frequently the site of the infection, may be considerably enlarged and filled with blood. The loss of blood is sometimes so extensive that the intestines may be pale or anemic in appearance. In acute cases, in which death occurs early, only slight changes may be visible. A microscopic examination of the intestinal contents is necessary in such cases in order to verify the post-mortem findings and make an accurate diagnosis.

Prevention and control.—Coccidia have a complicated life cycle, a part of which is passed in the intestinal cell, finally resulting in the formation of oocysts that are discharged. The oocysts are non-infective at first but must undergo certain developmental changes after being passed from the host before they can infect other birds. When the oocysts are ingested immediately after being passed, no infection results. The development of the oocyst from a noninfective to an infective stage, however, usually takes place within 24 to 48 hours after passage in the droppings. Coccidiosis can be successfully controlled if measures are taken to prevent birds from coming in contact with contaminated litter or feed after the oocysts have become infective. Solid floors should be cleaned daily, but placing birds in runs with wire-mesh floors will give the most satisfactory results in controlling an infection, since the severity of the disease depends upon the number of oocysts consumed. Investigators find that coccidia are readily destroyed by sunlight and drying and that digging up and aerating the polluted soil of a pen is an important preventive or control measure.

Overcrowding should be avoided, and birds that are maintained in rearing pens should be moved frequently to sites previously unused. Many wild birds are infected with coccidia to a limited extent, and the organisms sometimes increase in number and become pathogenic. This situation may result from keeping too many birds in the same pen or from repeated use of the same range. Mature birds appear to have a pronounced resistance to infection with coccidia; this is probably due to an immunity built up by a previous light infection.

There is no known effective treatment for coccidiosis. A number of medicinal treatments and special feeds have been placed on the market, but those thus far tested have proved unsatisfactory. The

disease runs a limited course. By the time a large number of oocysts appear in the droppings it has reached a climax. Treatment at that time apparently has little or no beneficial effect.

BLACKHEAD (ENTEROHEPATITIS)

Blackhead is caused by a protozoan organism that affects the intestines and liver. Although it is considered primarily a disease of domestic turkeys, it also affects most of the upland game birds; thus it is of major economic importance to game breeders. It has been observed in quail, wild turkeys, ruffed grouse, Hungarian partridges, and ptarmigan. The infection is an especially serious problem on quail farms, particularly during the latter part of the breeding season. Mortality is much higher among the hens than among the cock birds; probably because of the heavy strain on the vitality of the hens during the egg-laying season. Blackhead occurs at all seasons of the year and may have serious results when large numbers of birds are held in winter pens. Very young birds may be infected unless proper measures of prevention are taken, but the mechanical methods now practiced in brooding reduce the hazards from this disease.

Cause.—The causative organism (*Histomonas meleagridis*) multiplies in the caeca and, after invading the intestinal wall, is carried by the blood to the liver. It is discharged in great numbers in the droppings of affected birds, and in a resistant form the parasite may retain its vitality in the soil for a year or more.

Spread.—Chickens are susceptible to blackhead, though fatal cases seldom occur. Recovered birds sometimes serve as carriers in spreading the infection. The disease may also be spread through the agency of caecal worms and their eggs. Within the worm eggs the blackhead parasite may retain its vitality for a long period, these eggs having shells that are resistant to climatic conditions. Earthworms and insects may act as mechanical carriers of the infected worm eggs, but the infection is spread principally by keeping birds in polluted ground pens.

Symptoms.—Affected game birds may or may not show noticeable symptoms. In acute cases apparently normal birds may be found dead, while in chronic cases the birds become stupid and sluggish and show a marked loss in weight.

Post-mortem appearance.—The lesions in game birds are characteristic and can usually be recognized. The caeca show intense inflammation and are filled with firm cores of cheeselike material. Loops of the intestines may be found grown together and often cannot be separated. Circumscribed areas of degeneration in the liver (fig. 3), which are the most common lesions in turkeys, are seldom found in quail.

Prevention and control.—There is as yet no successful treatment for blackhead, but it can be prevented and effectively controlled by sanitation. Although chickens are highly resistant, they may act as carriers, and blackhead will be a problem on game farms where chickens are used for brooding. The disease can be prevented in young birds by using mechanical incubators and brooders. Many game breeders believe that the confinement of growing birds in pens on

the ground is conducive to proper body development and growth, but when such pens are used they should be moved frequently to prevent infection in young birds.

Where blackhead is a serious problem in breeding birds during the summer months, wire-floored laying pens are recommended as a preventive measure, since this method of handling does not appear to affect either egg production or fertility. On many game farms such pens are used both as laying pens in summer and as holding pens in winter. At all seasons overcrowding should be avoided.



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FIGURE 3.—Blackhead lesions in the liver of a ruffed grouse. The lighter-colored areas of degeneration (yellowish white in the organ) are characteristic of this disease.

TRICHOMONIASIS

Trichomoniasis, a highly fatal disease of young quail and grouse, is caused by a flagellated protozoan of the genus *Trichomonas*. An organism that resembles *T. gallinarum* is found in great numbers in the intestinal discharge of affected birds. Outbreaks attended by severe losses have occurred in propagated quail and grouse. Little, however, is known concerning trichomoniasis or its causative organism, and its importance in propagated and wild birds still remains to be determined.

The disease most commonly appears about the second week after hatching and rarely affects birds more than a month old. The sick birds huddle together, their feathers become ruffled, and their wings droop. The disease is usually accompanied by an ill-smelling, foamy-appearing, grayish-green diarrhea. Autopsy reveals a gen-

eral anemic condition in some cases and caeca enlarged and distended with contents of the same appearance as the droppings.

Flies help to spread the disease, and where it is impossible or impracticable to screen against them, the incidence of the infection can be somewhat reduced by placing the birds in runs having wire-mesh floors and following the general hygienic procedure here recommended (p. 3).

The feeding of buttermilk or sour milk is of questionable value in the treatment of trichomoniasis and is to be discouraged because it attracts flies.

MALARIA

Bird malaria is caused by a protozoan parasite that invades the red blood corpuscles. The infection is widespread in certain European countries and in some instances results in a high mortality. The infection in the bobwhite quail of the Southeast has been attributed chiefly to the species *Plasmodium praecox*. Little is known about the mode of transmission of this organism or its effect on the host. Affected individuals have dull plumage and many are emaciated. A protozoan organism (*Haemoproteus lophortyx*) has been found in the blood of California, Gambel's, and Catalina Island quails; it is transmitted from one bird to another by a louse fly. This infection was found to be widely distributed in the States of the Pacific Northwest, with fatal terminations in many cases, and it is believed to be responsible for widespread losses that are frequently attributed to other causes.

LEUCOCYTOZOOM INFECTIONS

A highly fatal malarialike disease caused by a protozoan blood parasite (*Leucocytozoon anatis*) similar to that causing bird malaria, is widespread among wild ducks in the North Central States. Infections with undetermined species of *Leucocytozoon* also have been reported in the spruce grouse, the ptarmigan in North America, and the red grouse in Great Britain. The organism affecting ruffed grouse has been identified as *L. bonasae*. Little is known concerning the importance of such infections in other wild birds.

SARCOSPORIDIOSIS

Protozoan organisms known as sarcosporidia are frequently found affecting the muscle tissues of various mammals and birds. The condition is more common in waterfowl than among upland game birds. The organisms are as yet little known, and the mode of their transmission has not yet been demonstrated.

In the carcass, the organisms appear as white or yellowish-white elongated objects about two- to three-tenths of an inch long and one to two twenty-fifths of an inch wide. Lying parallel to the muscle fibers, they have the appearance of small grains in the tissue and may vary from a very few to such a gross infestation as to give the flesh a gray appearance.

Birds are evidently highly tolerant to this organism, and even though it may be present in great numbers it does not seem to cause serious inconvenience. Birds have been shot that were apparently in good health, despite massive infestations with sarcosporidia. Avail-

able information indicates that in the encysted stage the organism is noninfectious for carnivores, and though eating the flesh of affected birds is not to be encouraged, it is not thought that injury to man would result.

WORM INFESTATIONS

ROUNDWORMS (NEMATODES)

GAPEWORMS

In various wild species of birds a worm parasite of the trachea, known as the gapeworm (*Syngamus trachea*), may cause considerable loss. It is especially injurious to young chicks but may also be of much annoyance to adults. The worms are about three-fourths of an inch long and bright red in color and have been collected from pheasants, ruffed grouse, quail, chukar partridges, wild turkeys, and peafowl. Though they attach themselves to the mucous membranes of the trachea to suck the blood, they may cause death by interfering with respiration. Affected birds may be seen repeatedly gaping in an effort to get their breath as the trachea may be partly closed by several large worms lodged there. Stoppage of the trachea sometimes becomes complete, and the birds die quickly of suffocation.

Treatments are not generally considered practicable. The use of a horsehair loop or a feather with most of the web removed has been found convenient in dislodging the worms in such birds as can be handled, and the operation is facilitated by dipping the hair or feather in ether, kerosene, or turpentine. Various contrivances, composed of fine flexible wire to aid in detaching the worms from the mucous membrane, have also been placed on the market.

To prevent gapeworm infestation, other species of birds should be excluded from the pens of game birds. As a hot, dry environment is unfavorable to the development of gapeworm eggs, pen sites should be on dry sandy soil.

TRICHOSTRONGYLUS

A small elongated roundworm (*Trichostrongylus tenuis*) that may reach a length of about half an inch is found in the caeca and small intestine of game birds, where it subsists on the contents and interferes with the passage of food. It requires no intermediate host for transmission. The eggs hatch after being passed in the droppings, and the larvae become infective after a short period of development; they are then ingested with the food. This worm is most seriously injurious to young or half-grown birds. It is common in quail as well as in other game birds.

CAPILLARIA

Two species of small, white, threadlike worms (*Capillaria annulata* and *C. contorta*) that may reach a length of about three-quarters of an inch are occasionally found imbedded in the esophagus and crop of game birds of all species. Their action in burrowing causes inflammatory changes and a thickening of the tissues. The life cycle of *C. annulata* is known to require an intermediate host (earthworm), but that of *C. contorta* has been reported to be direct. On game farms sanitation is the only control measure that can be recommended.

PROVENTRICULAR, OR STOMACH, WORMS

A common nematode (*Dispharynx spiralis*), found in the glandular stomach of domestic chickens, is also a parasite of grouse, quail, pheasants, and other game birds. The worms burrow into the wall of the proventriculus and cause a thickened and ulcerated condition. They are short and thick, approximately a quarter of an inch long. It is reported that young birds do not readily withstand heavy infestations, but complete studies of these worms in game birds have not been made. The pillbug and sowbug serve as intermediate hosts.

GIZZARD WORM

The gizzard worm *Cheilospirura spinosa* has been observed in quail, grouse, pheasants, and sage hens. It is a threadlike worm of yellowish or reddish tint, slightly more than 1 inch long and is ordinarily found in the muscular walls of the gizzard beneath the horny lining, generally near the openings of the organ. Sometimes the inflammation produced is sufficient to cause a loosening and actual sloughing of the lining. This parasite may be transmitted to susceptible birds through grasshoppers, in which the larval worms encyst.

CAECAL WORMS

Heavy infestations of white nematodes (*Heterakis gallinae* and related species) sometimes develop in the caeca of wild turkeys, sage hens, ruffed grouse, and quail. These worms average a little less than half an inch in length. The only apparent injury is an interference with the passage of food in the caeca, but heavily infested birds are usually unthrifty. These parasites have no intermediate host, though various annelids and insects may aid in spreading the eggs.

EYE WORMS

A species of roundworm (*Oxyuris petrowi*), similar to *O. mansoni*, a parasite long recognized as affecting the eyes of domestic chickens, has recently been observed in wild grouse in Michigan. It is a small, threadlike, almost transparent worm, attaining a length of approximately 1 inch, and is found beneath the nictitating membrane. *O. mansoni* has been found in chickens in Florida and Louisiana, and experimentally the cockroach has been demonstrated to be an intermediate host. The species occurring in grouse in Michigan is similar to those found in the poultry of the Gulf Coast States. The intermediate hosts of the eye worm of grouse in the Great Lakes region have not yet been determined.

Eye worms cause an irritation of the membranes of the eyes, producing an excessive secretion, which as it exudes and dries, glues the lids. The irritation causes swelling of the orbit and may terminate in blindness. Complications that may take place following infestation with eye worms are often more injurious than the mere presence of the parasites themselves. Attempts of the grouse to relieve the condition aggravate the inflammation, increasing pus formation.

Once the intermediate host of the grouse eye worm is recognized, it may be possible to institute control measures. For treatment in chickens, poultrymen apply a mild local anesthetic and then, after lifting the nictitating membrane, drop a small quantity of 1-percent compound cresol solution directly on the worms; this promptly kills them. Immediately after the drops have been applied, fresh water is used to wash away the solution before it causes extensive irritation. This procedure may be followed with birds under control on game farms.

OTHER NEMATODES

Other species of nematodes inhabit various organs of game birds. Many of these cause no serious injury, but the lesions made where

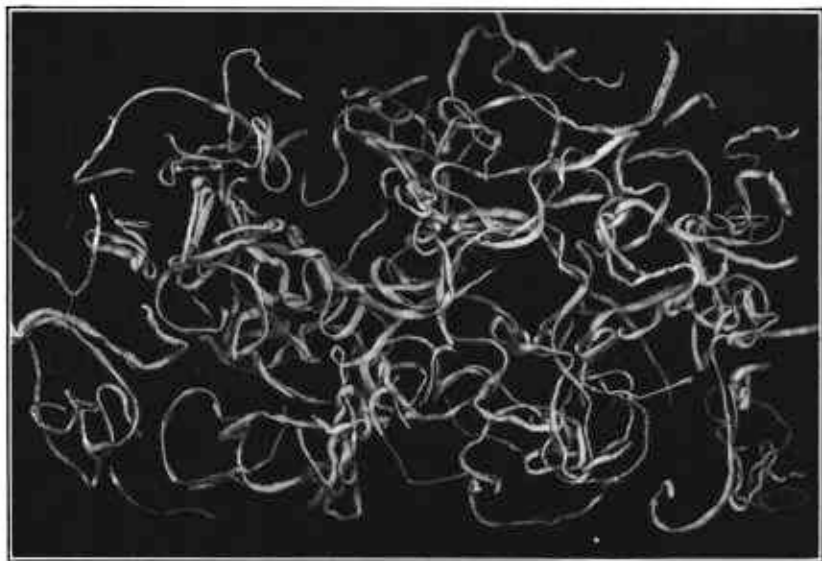


FIGURE 4.—Tapeworms of the genus *Raiilletina*, from adult bobwhite quail. Heavy infestations are not uncommon where quail are reared by bantam foster parents or closely confined on ground that has served as a poultry yard.

they attach themselves may furnish a portal of entry for pathogenic micro-organisms.

TAPEWORMS (CESTODES)

Tapeworms are flat worms composed of many segments (fig. 4), each a more or less complete organism that is capable of absorbing food and producing eggs. They are white or slightly pink and are attached by a so-called head to the interior of the intestinal wall. Some species have at the tip of the head a crown of small hooks which aid in attachment and in burrowing into the mucous membranes. Attachment of some species is also facilitated by four sucking disks symmetrically arranged on the sides of the head.

Tapeworms possess neither mouth parts nor enteric canal; they thrive apparently by absorbing the intestinal contents of the host.

These parasites, having an indirect life cycle, require at least one intermediate host to complete the larval stage of development. The intermediate hosts for species whose life cycles are known are flies, beetles, and snails. The gravid segments containing the eggs usually pass out with the droppings and become encysted in the bodies of insects, snails, or slugs, which in turn are eaten by a susceptible bird and then develop into mature parasites in the intestinal tract.

It is possible to control tapeworms effectively on game farms by employing such sanitary measures as proper disposal of droppings and by eliminating the intermediate hosts to such an extent that they will not be a menace to the birds. Medication with kamala or other anthelmintics may be resorted to for relieving seriously affected individuals.

EXTERNAL PARASITES CAUSING DISEASE

Many kinds of external parasites thrive on game birds during certain seasons or under suitable conditions. Some have biting mouth parts and feed on the feathers and superficial skin. Others have long projecting mouth parts, which they insert deep in the flesh in withdrawing blood. All do more or less harm, though it may not be apparent except in extreme cases.

LICE

In the wild, quail, grouse, and pheasants seldom become heavily infested with lice. The habit of the birds to take dust baths, to preen their plumage, and to pick the parasites from themselves as well as from their companions probably keeps natural infestations in check. Birds may be seen delousing affected companions, and the remains of lice are found in the digestive organs. When individual birds are heavily infested they are usually in poor flesh, though this may be caused by conditions other than louse infestations. Some investigators, therefore, maintain that heavy infestations with lice are secondary to other pathogenic conditions.

Types.—Several species of biting lice are found on game birds. On quail, *Goniodes mammillatus* is frequently observed, as well as *Lipeurus clavatus* and *L. dissimilis*. These species also have been found on larger game birds, especially grouse and sage hens. Other species have been collected from game birds, but ordinarily they are not important. Where game birds are hatched and brooded under domestic poultry, the young may become parasitized from louse-infested foster mothers.

Spread.—Lice are spread through contact of birds with others that are infested or by brooders, nests, or other equipment in which parasitized birds have been kept. Birds confined under unnatural conditions are apt to develop heavy infestations.

Symptoms.—Ruffling the feathers of the head and twitching the head in spasmodic movements are frequently the only noticeable symptoms. Almost invariably game birds carrying a heavy louse infestation are in poor flesh. It is difficult to determine, however, whether the lice were primarily responsible for the condition or had become exceptionally numerous on otherwise unhealthy birds. In

either case they do cause specific injury to the host and should be eradicated.

Control and prevention.—In the wild it is probable that the natural dusting habit of all upland game birds keeps lice under control. On game farms simple methods only are required to prevent excessive louse infestations. Ordinarily providing a good dust bath will suffice. If individuals are found with heavy infestations, it is efficacious to use sodium fluoride either as a minor ingredient of the dust or as a liquid bath, dissolving 1 ounce of the chemical in 1 gallon of water.

In raising game birds under controlled conditions, the same nests and coops must sometimes be used for different groups during one season. Strict sanitation should be maintained to prevent infestations. The nest boxes and coops should be so constructed as to be easily disinfected, and all nesting materials should be burned after each brood has been removed.

MITES

Several species of mites attack quail, prairie chickens, pheasants, and grouse, and though these parasites have rarely been reported as causing extensive injury, some forms do penetrate the skin rather deeply, especially on parts where the feathers are not dense. Chiggers, or red bugs (*Trombicula irritans*), have been observed on enlarged, inflamed areas of the skin of game birds in various parts of the country. A species of tropical fowl mite (*Liponyssus* sp.) also has been found occasionally on quail.

Spread.—Since during a part of their life cycle chiggers are free-living, some are picked up by wild birds ranging through infested cover. The tropical fowl mite may complete the life cycle on the host and, therefore, may be transmitted by direct contact. Abandoned nests also have been found to harbor mites and thus may aid in their spread.

Symptoms.—Birds infested with mites generally show no peculiar behavior, though the parasites, if sufficiently numerous, may produce an anemia with its characteristic debilitating effects. Examination of infested birds also reveals an injurious local action in the form of an inflammation that may sometimes reach the point of local ulceration.

Control and prevention.—Little can be done to mitigate the menace of mites, since heavy infestations are not sufficiently frequent to call for systematic control. If it becomes known that mites are present in flocks on game farms, it is recommended that sitting birds and their nests be dusted with sulphur. Other stock may be treated similarly or with a sulphur solution instead.

TICKS

Ticks will probably never constitute a serious problem on game farms, but some species become exceedingly numerous on game birds in their natural environment, especially on grouse in the North Central States. A few ticks of many species often are found on quail, grouse, sage hens, and wild turkeys. Frequently these are immature forms, which as adults are more or less specific parasites of certain mammals. A few individuals of such species in the adult stage may rarely be found on game birds also.

A true bird tick (*Haemaphysalis chordeilis*) has been reported rather frequently on all the common species of game birds in the United States. These ticks are relatively small, the adult females when fully engorged being not more than three-eighths of an inch long. They range in color from light gray as young adults to a reddish brown when engorged. The males in the adult stage seldom become more than a third as large as the engorged females. In a few instances heavy local losses diagnosed as being caused by these ticks have been reported. The extent to which these parasites may be a factor in game-bird losses cannot be stated until more information is available.

The rabbit tick (*Haemaphysalis leporis-palustris*) is the species most commonly found on North American game birds (fig. 5) and has been reported from practically all parts of the United States.



FIGURE 5.—Removing ticks from ruffed grouse for laboratory study.

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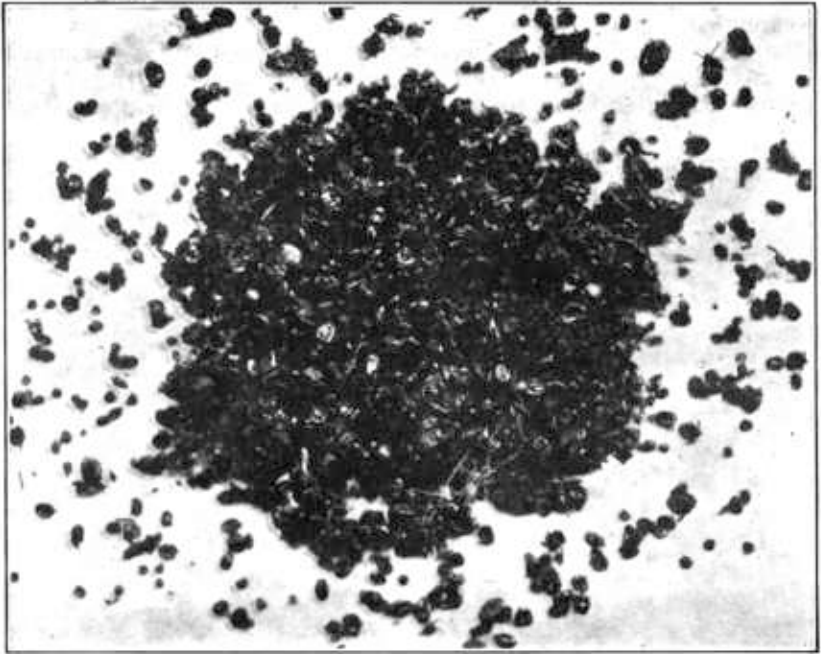
It is smaller than the bird tick, the adult engorged females measuring not more than one-fourth of an inch in length. In some sections bird hosts become heavily infested at certain seasons of the year, notably ruffed grouse in Minnesota and adjacent States. It is not uncommon to find individual birds harboring several hundred of these ticks, and in a few instances more than 2,000 have been collected from an individual grouse (fig 6). They are attached in greatest numbers about the head and neck.

In addition to producing a definite mechanical irritation and sucking blood, species of ticks liberate, in the body tissues, toxins that give rise to local inflammation. The greatest potential danger from infestations lies in the ability of the parasites to transmit disease from affected to healthy individuals. The fact that most species require two hosts for the completion of their life cycle increases the possibility of a rapid spread of disease in areas heavily infested. Under certain conditions this group of parasites may be a serious menace in spreading tularemia and other diseases to game. Some author-

ities ascribe the dissemination of infections that cause a periodic disappearance of game to the abundance of ticks. As a means of eliminating great numbers of these parasites carefully controlled burning of the ranges may be prescribed.

FLEAS

Fleas are of small importance on game birds. These parasites are of rare occurrence, and severe infestations have never been reported.



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FIGURE 6.—A group of rabbit ticks (*Haemaphysalis leporis-palustris*) removed from the ruffed grouse shown in figure 5. These ticks formed part of an extremely heavy infestation.

NUTRITIONAL DISEASES

A deficiency or lack of balance of nutritive elements and vitamins in the ration of game birds may cause various phases of poor health. These manifestations are usually quite specific, and a determination of the particular vitamins or elements lacking can be made from the symptoms observed or on autopsy. Some of these conditions are readily corrected by a proper adjustment of the ration, while the injury from others is permanent.

Wild game birds that have the opportunity to select their own food are seldom affected with what are ordinarily called nutritional diseases, though at times they may be undernourished. On the other hand, pen-raised birds given a liberal allowance of properly balanced feed attain a distinctly larger size than the average wild birds of the same species.

NUTRITIONAL ROUP

Nutritional roup is distinctly a disease associated with an unbalanced diet and is most common in birds during the latter part of the developmental stage. Young chicks and adults, however, may be similarly affected if kept over a long period on a restricted diet.

Cause.—A deficiency of vitamin A in the ration is responsible for nutritional roup in birds. This disease is not contagious, but it may have the appearance of an infectious epizootic. Numbers of birds in one or in several pens when fed the same ration may show symptoms simultaneously, and thus both the onset and the course of the disease may simulate an infectious condition.

Symptoms.—Affected birds show a watery discharge from the nostrils and eyes, the latter becoming inflamed with an accumulation of cheeselike material under the lids. The eyelids may be glued together with the drying discharge and the accumulation of the cheesy material. Later the birds become sluggish and gradually weaker until death. In quail there is often a loosening of the feathers, and when these are shed through handling or by crowding, the victims have a ragged appearance (fig. 7).



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FIGURE 7.—Adult quail hen affected with nutritional roup. Loss of feathers, weakness, and swelling about the eyes are characteristic of a deficiency of vitamin A. After 20 days' treatment with cod-liver oil this bird resumed egg laying.

Post-mortem appearance.—On autopsy the lesions in the mouth, pharynx, and esophagus are easily seen. They consist of deposits of grayish-white cheeselike substance frequently imbedded in the superficial layers of the mucous membrane. In some cases they become so extensive as to give the entire surface of these organs a grayish appearance. In addition, whitish-gray deposits appear on the surface of the viscera. On the kidneys these are usually small, but numerous enough to give a pale-grayish cast.

Cure or prevention.—Nutritional roup responds readily to a corrected ration. Except in advanced cases cure may generally be expected, especially if the bird's appetite is good. Addition to the feed of potent cod-liver oil, green leafy vegetation, finely chopped or ground carrots, tomatoes, and egg yolk is recommended.

RICKETS

Rickets is a nutritional disease, the chief manifestation of which is improper bone development. This is brought about by the bird's inability to assimilate the required quantity of lime and phosphorus.

Cause.—A deficiency of vitamin D in the ration is known to be the responsible factor in rickets. Most rations contain the necessary quantity of lime for bone building, but this element appears to be made available only in the presence of the necessary supply of vitamin D, which is obtained from certain food substances or through the action of direct sunlight. Like other nutritional diseases, rickets may affect many birds at the same time. This is due, however, not to any contagion but to the similarity of the conditions under which all are kept.

Symptoms.—A deformity of the legs becomes evident in advanced cases of rickets. This may be preceded by lameness and a weakening of the joints. The breastbone also may be deformed.

Post-mortem appearance.—Dissection of diseased birds so as to expose the skeleton usually shows a deformity of the bones of the leg and breast. Their structure is soft and porous. The intestinal tract appears to lack tone, and occasionally there is a considerable mucous exudate.

Cure or prevention.—The addition of cod-liver oil as 2 percent of the ration will prevent rickets or cure incipient cases. If growing birds are given a liberal supply of green feeds and directly exposed to sunlight rickets will be prevented and it will not be necessary to give cod-liver oil.

SLIPPED TENDONS

On game farms the young chicks of certain species are especially subject to a functional disease recognized by the deformity it produces. As a result of a nutritional irregularity the tendons of the legs become relaxed and displaced, causing extreme flexion of the joints.

Cause.—Until recently it was supposed that slipped tendons resulted either from injuries or from an inherited weakness. The cause has been demonstrated, however, to be a deficiency or a lack of balance of mineral substances in the diet or failure in assimilation of phosphorus and calcium that may be governed by certain vitamins. The mineral reserve in the system appears to keep many birds in good condition, while others, fed on the same ration and in the same environment, show the effects of disease. It is not unusual for the major part or all of the brood to be affected.

Symptoms.—Birds having slipped tendons show at the onset an enlargement of the large joint of the leg known as the hock joint, which may be discolored from a hemorrhage beneath the skin. Various malformations of the legs follow, and in advanced cases they assume such extremely grotesque shapes (fig. 8) as to make the bird an object of pity in its effort to walk. The appetite usually remains unimpaired, and despite great difficulty in moving about, some affected individuals attain an almost normal body development.

Post-mortem appearance.—Examination of the tissues of the leg bones reveals a tendency of the lower end of the tibia and the upper end of the metatarsal bones to bend. An accompanying relaxation of the sheaths through which the tendon slides allows the large tendon on the rear of the leg to slip around the joint. This combination of abnormalities causes an extensive growth of fibrous tissue and a distinct enlargement.

Prevention.—There appears to be no cure for slipped tendons after actual deformities have developed, and insufficient work has been

done to determine just what elements are required to prevent the malady. The exact nature of the food deficiencies causing the disease is not known, but certain feeding methods have been found effective in its prevention. In domestic chickens, slipped tendons can be prevented by making rice bran 5 to 10 percent of the ration or wheat middlings about 20 percent of the mash. On game farms, birds fed whole-milk clabber were not affected but others raised on skim-milk clabber developed the disease.

DIGESTIVE DISTURBANCES

It has been found difficult under artificial environment even to approach the variety in the food supply that game birds obtain under natural conditions.

After many different experiments, the rations now more commonly recommended are composites, including cereals and other seeds, meat products, curdled and dried milk, bone-meal, ground oyster-shell, and charcoal, supplemented with succulent green vegetation and fruits. If of good quality, all these substances are useful, but digestive disturbance may ensue if they are improperly used, more commonly among young birds, however, than among adults.

Cause.—Overloading the digestive organs by liberal feedings after long fast-

ing, giving seeds or other objects too large to be easily digested, or supplying too much of certain forms of feed and substances that cannot be properly acted upon by the digestive fluids may produce an inflammation of the digestive tract or other disturbances. These conditions have been encountered in wild game birds as well as in pen-raised stock. Engorgement and impaction of the crop with tough fibrous vegetation, when there is not enough moisture in the food or insufficient water available for drinking, have been noted in dead birds found in areas of excessive drought. Shortage of grit also is a potential source of digestive disturbance. Clabber or wet mash that has become fermented is especially harmful. Some seeds frequently incorporated in bird-feed mixtures contain an excess of irritating oils that may cause gastritis and diarrhea.



FIGURE 8.—Prairie chicken, showing leg deformity caused by displaced (slipped) tendons.

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Symptoms.—Birds affected with digestive troubles are usually stupid, remain quiet most of the time, and eat little. The feathers stand out in a loosely ruffled position, and the wings are drooped.

Post-mortem appearance.—On dissection, the digestive organs of individuals affected with indigestion may show inflammation in any part. On the other hand, there may be an absence of any apparent inflammation or irritation, characteristic of those cases in which digestive secretions have been deficient.

Cure or prevention.—The first step in the treatment of practically all cases of indigestion is to clear the digestive tract with a purgative. For this purpose a solution of 1 part of Epsom salt in 20 parts of drinking water may be used as a drench administered through a small rubber tube. Castor oil mixed in the feed or given in capsules or as a drench with a syringe, at the rate of 5 drops for an adult quail, is also effective in emptying the digestive tract. The dosage should be graduated to suit the size of the bird treated. Buttermilk also has been found an effective purgative. In the choice of feed intended to correct digestive disturbances, careful attention should be given to the ration and to the changing requirements of birds of different ages as well as of different species. After purgation, the birds should be fed lightly for a day or two. Milk is easily digested and is a good feed for convalescing birds. If the appetite for normal food does not return after several days, a small quantity of pepper or mustard seed may be added to the ration as a tonic.

BOTULISM (FOOD POISONING)

Some forms of food may become contaminated with bacteria, which during their process of growth at favorable temperatures produce a highly potent poison, or toxin. The bacteria themselves are relatively harmless—it is the product resulting from their development that is injurious.

Cause.—Several species of bacteria may be responsible for this form of food poisoning, but with birds that most common is *Clostridium botulinum*. This grows in various forms of organic matter in surroundings that are more or less alkaline. So potent is the toxin that a very small quantity taken with the feed may seriously affect or even kill the birds.

Spread.—Botulism is not infectious and therefore is not communicable from bird to bird through contact or association. It usually, however, attacks most or all the birds that eat the same contaminated food and thus may have the appearance of a contagion.

Symptoms.—The toxin has a distinct affinity for the nerve tissues and in fact destroys nerve cells; the extent of the injury to the nerves determines the seriousness of the cases. The birds exhibit a depressed attitude, and diarrhea may be present in the early stage. The first evidence of weakness is inability to fly. Affected birds have a tendency to remain sitting a great deal of the time and stagger if forced to walk. Their inability to hold up their heads has given the condition the popular name “limberneck.” In more advanced cases, ability to walk or fly is lost completely, and there is a prostration of all muscles before death.

Post-mortem appearance.—Little can be seen on autopsy to indicate the nature of the disease without recourse to laboratory procedures. More can be learned by noting the ante-mortem behavior and history.

Prevention.—Providing only fresh, uncontaminated feed and water is the only effective preventive measure. The use of antitoxin as a cure is possible but impracticable. It is important to see that decaying organic matter is not allowed to accumulate within reach of the birds. Some game farmers have been accustomed to place sheep's heads and other packing-house offal in the developing and holding pens to make numerous blowfly larvae available for bird food. Although it is true that scoured larvae constitute excellent food, there is danger that uncleaned larvae may be laden with botulinum toxin and cause the death of birds eating them.

Pheasants reared in large fields overgrown with vegetation are frequently affected with food poisoning from eating blowfly larvae bred in carcasses of dead birds.

OTHER PATHOLOGICAL CONDITIONS

RESULTS OF ANT ATTACKS

Ants, technically predators, are known to be very destructive to quail eggs in natural nests in the Southeastern States. Large numbers of the small red ant (*Solenopsis molesta*) frequently prey upon the hatching chick within piped eggs. On game farms such losses may be controlled by the use of gasoline, kerosene, or carbon disulphide applied to the ant burrows with an oilcan or small syringe. Similar measures may be partially effective in the wild, though ant elimination there is impracticable.

EFFECTS OF CANNIBALISM

Game birds confined in small pens or brooders frequently peck each other, attacking most frequently the toes, bill, and rump. The habit appears to be most common in groups maintained on floors not covered with litter. The injuries may be extensive, and death may result if the victims are not removed and treated. The habit is quickly acquired by an entire brood if a few vicious birds are allowed to continue. A remedial measure is to clip off the extreme tip of the bill.

MINERAL AND OTHER POISONING

Lead poisoning, which has been found destructive to waterfowl that swallow shot picked up in marshes where there has been much hunting, is not known in upland game birds. This is probably because a range occupied by upland game seldom has such concentrations of shot as may be found where waterfowl are hunted, and the upland species therefore have little opportunity to pick up lead. They are known to be susceptible to the toxic action of lead when ingested.

Salt poisoning has been reported on game farms where the feed has been contaminated by ingredients containing salt; normally no salt is used.

Sodium nitrate, which is frequently used as a fertilizer in parts of the Southeast, is a potential source of poisoning in quail. This is especially the case if it is applied to the soil in a dry time and not promptly incorporated.

Rose chafers, or rose "bugs", are poisonous to game birds when eaten in quantities. They appear to be particularly harmful to the young and where numerous may cause a considerable loss of birds a few weeks old. On game farms the only satisfactory preventive measure is to screen brooder houses and runs.

Poison baits placed for purposes of pest control, as in grasshopper plagues and rodent infestations, have been said to cause losses among upland game bird. It is conceivable that by eating certain of these substances in sufficient quantity game birds might be seriously or fatally affected, but the evidence is that in properly conducted operations such losses seldom occur. Quail, grouse, and other gallinaceous birds are remarkably tolerant of strychnine, which is the active agent in many rodent baits.

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